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The Potential for Gains in Predictive Ability Through
Disaggregation: Segmented Annual Earnings

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The Potential for Gains in Predictive Ability
Through Disaggregation: Segmented Annual Earnings

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Abstract

The purpose of this paper is to derive and examine the conditions
under which the disaggregation of entity earnings, into sub-entity
earnings, could lead to gains in predictive ability. Annual earnings
before extraordinary items and discontinued operations is the variable
of interest. Simulated mergers of existent autonomous firms are used to
provide comparable CN-SG data.

For segmented gains to occur, at least one of two necessary
conditions must be satisfied. Either the time series models for the
segmented firms must be nonidentical or at least one of the segment
earnings series must serve as a leading indicator of the consolidated
income. Based on previous research (and our results for single-product
firms) favoring the random walk, the first of these two conditions is
not generally satisfied. Furthermore, our data did not provide support
for the satisfaction of the second condition.

THE POTENTIAL FOR GAINS IN PREDICTIVE ABILITY
THROUGH DISAGGREGATION: SEGMENTED ANNUAL EARNINGS

Research related to corporate earnings has been extensive because earnings are the focus of financial reporting in the United States (FASB [1978]). Recently, both the Financial Accounting Standards Board and the Securities and Exchange Commission issued guidelines for reporting annual earnings on a sub-entity basis (FASB [1976, 1977]; SEC [1977, 1978]). Presumedly, these disclosures can be used by investors to improve predictions of total-entity profits. Since one would expect investors to utilize the best forecasts available (Muth [1961]), researchers, in search of such forecasts, have examined the relative predictive ability of consolidated (CN) versus segmented (SG) financial disclosures.

The results of previous CN-SG research are mixed. While CN forecasts have been generally less accurate than SG forecasts (e.g., Kinney [1971]; Kochanek [1974]; Collins [1976]), these differences could be situation specific rather than general (e.g., Barefield and Comiskey [1975]; Fried [1978]; Ang [1979]; Barnea and Lakonishok [1980]; Silhan [1980]). Furthermore, annual SG profit data do not seem to contribute to forecast improvements beyond improvements attributable to SG sales data (e.g., Kinney [1971]; Collins [1976]; Emmanuel and Pick [1980]).

Unfortunately, previous comparisons were restricted by data availability and model specifications. Segment reporting was new and data-consumptive techniques could not be used. In addition, the same models could not be used across competing CN-SG data sets, and data x model interactions may have affected the results. Furthermore, preceding studies did not establish the general conditions necessary for disaggregation gains.[1]

Our research derives and examines the conditions under which the disaggregation of entity earnings, into sub-entity earnings, could lead to gains in predictive ability. Annual earnings before extraordinary items and discontinued operations is the variable of interest. Simulated mergers of existent autonomous firms are used to provide comparable CN-SG data.

Simulated Mergers

Simulated mergers provide an approach to segmentation research that overcomes some of the previous limitations (Silhan [1982]). In effect, hypothetical n-segment conglomerates are created by simulating mergers of existent firms. Autonomous single-product companies are used to provide "segmental" data for analysis. Since unrelated companies in unrelated industries would be expected to have few, if any, intersegment transfers,

single-product companies can be screened to minimize potential intercompany transactions. Since these conglomerates consist of autonomous firms, allocations of common costs and taxes are avoided. Each firm is a separate entity in every way.

Another advantage of the simulated-merger approach is that it provides a means for specifying certain composition character-istics and contexts that could affect CN-SG differences. The number of segments (NOS), for example, can be specified for a given set of mergers. Barefield and Comiskey [1975] suggest that an NOS effect may influence CN-SG differences.

Conditions for Improved Forecasts
From Disaggregation

In abstract statistical terms, there are certain conditions which lead to forecast improvements from disaggregation. Consider a conglomerate whose earnings in year t, X_t, are the sum of m components $X_{i,t}$ (i = 1, 2, ..., m), so that

$$X_t = \sum_{i=1}^{m} X_{i,t}.$$

Suppose, at time n, we wish to predict future values of total earnings, X_{n+h} (h > 0), given

(i) past values, X_{n-j} (j $\geq$ 0), of total earnings

(ii) past values, $X_{i,n-j}$ (i = 1, ..., m; j $\geq$ 0), of earnings for each component.

If the autoregressive-integrated-moving average (ARIMA) models generating $X_{i,t}$ are denoted, in the notation of Box and Jenkins [1970], as

$$\phi_i (B) (1-B)^{d_i} X_{i,t} = \theta_i (B) a_{i,t} \qquad (i = 1, \ldots, m)$$

where B is a backshift operator on the index of the time series and $a_{i,t}$ is white noise, then predictions of future values of the individual earnings can be calculated in a straightforward way.

Under certain conditions, however, it can be shown that <u>no gains</u> in forecast accuracy will result from using the disaggregated series. Suppose that

(a) the parameters of the models for each component are identical, so that all are generated by models of the form

$$\phi (B) (1-B)^d X_{i,t} = \theta (B) a_{i,t} \qquad (i = 1, \ldots, m)$$

(b) the only non-zero correlations of the form

$$\text{Corr} (a_{i,t}, a_{j,t-k}) \qquad (i \neq j)$$

occur at $k = 0$.

If conditions (a) and (b) hold, the forecasts based on X_{n-j} $(j \geq 0)$ will be identical to those based on $X_{i,n-j}$ $(i = 1, \ldots, m;$ $j \geq 0)$. This can be shown by developing the model for X_t. We have

$$\phi \ (B) \ (1-B)^d \ \sum_{i=1}^{n} X_{i,t} = \theta \ (B) \ \sum_{i=1}^{n} a_{i,t}$$

or

$$\phi \ (B) \ (1-B)^d \ X_t = \theta \ (B) \ a_t$$

where

$$a_t = \sum_{i=1}^{m} a_{i,t}$$

and is white noise by virtue of (b). Thus the model for the aggregate series is identical in form to that of the individual series. It immediately follows that the same forecast will result if X_{n+h} is predicted from its own past as when individual forecasts are obtained for the $X_{i,n+h}$ and aggregated. For example, for one step-ahead prediction, the forecast error in the first case is a_{n+1}, which is simply the sum of the individual errors $a_{i,n+1}$.

A special case of some interest arises when each component series follows a random walk, a model frequently found using annual earnings. In such a case, condition (a) is, of course, satisfied.

Condition (b) is interesting. It implies that information on one component is of no value in predicting the future of any other. Naturally, if this were not so, disaggregation would inevitably produce useful information for prediction using a

multiple-series (multivariate) model, rather than a single-series (univariate) model.

Figure 1 summarizes the preceding analysis. It indicates the circumstances under which the use of disaggregated information will or will not yield improved forecasts of total earnings. The more dissimilar the time paths of the individual components (in regard to their autocorrelation structure), the greater the gains from disaggregation. Similarly, the stronger the relationship of any leads or lags between the individual components (in regard to the crosscorrelation structure), the greater the gains from disaggregation.

[Figure 1 About Here]

Research Design

A sample of hypothetical conglomerates was used to provide evidence regarding potential CN-SG differences in predictive ability. Given the observed characteristics of the data, we could test for potential forecast improvements by observing the existence or non-existence of the necessary statistical conditions for disaggregation gains to be achieved. The test proceeded in stages based on competing hypotheses derived from conditions (a) and (b). Decision paths regarding these hypotheses are depicted in Figure 2 which is referred to in subsequent discussion.

COMPETING HYPOTHESES

Identical parameters. Condition (a) requires that the compo-
nent models in a given conglomerate have identical parameters.
Additionally, it requires that the models be identical. This
stage required a comparison of individually derived models
against several "premier" models.

Box-Jenkins (BJ) analysis was used to identify non-premier
SG models. This approach assumes that ARIMA models can be fitted
individually to the component series. BJ models thus represent a
rejection of condition (a) since different (p,d,q) models would
necessarily involve different parameters. For the premier-model

[Figure 2 About Here]

path, two models were tested. Since previous time series
research had provided extensive evidence that annual earnings
follow a random walk (RW) pattern (e.g., Beaver [1970]; Ball and
Watts [1972]; Lookabill [1976]; Salomon and Smith [1977];
Albrecht et al. [1977]; Watts and Leftwich [1977]), a (0,1,0)
premier model was fitted to the SG data. An alternative premier
model, a (0,1,1) moving average (MA) model, was also fitted since
it too has received support in the literature[2] (eg., Fried
[1978]; Barnea and Lakonishok [1980]; Beaver and Lambert [1980]).
Due to its heavy support, the RW with drift model was considered
the null hypothesis for the underlying model.

Non-zero crosscorrelations. Condition (b) states that the crosscorrelations of the lagged components must be non-zero at all lags except lag 0 for predictive gains to occur. In other words, some of the SG series must be "non-coincidental". The path for this required condition is also depicted in Figure 2.

Given the existence of identical parameters, the second test involved crosscorrelations. If non-coincidental SG series were observed, condition (b) would not be satisfied. Potential dis-aggregation results are indicated on the right-hand side of Figure 2.

COMPONENT FIRMS

N-segment conglomerates were created from a sample of 35 single-product firms. These firms were domestic, nonregulated, calendar-year firms with positive average earnings (1950-76). Companies with restated data for mergers and other discontinuities were excluded from consideration.

Conglomerates were formed by adding together the component income streams. The pooling-of-interests treatment was chosen since all conditions for this treatment could be assumed without undue conjecture. Compliance with APB Opinion No. 16 seemed rea-sonable, and it was possible to avoid the valuation problems associated with the purchase treatment.

Only firms with unrelated products were merged together. Combinations which appeared to offer possibilities for synergism were excluded. The merging procedure screened companies for size and product characteristics. First, firms were ranked in descending order by average earnings. Then, firms were hypothetically merged in groups of two, three, four, and five. Inappropriate combinations were eliminated by regrouping similarly-sized firms until all 35 component firms could be merged without the appearance of potential synergism.

Firms were selected from Moody's Industrial Manual and COMPUSTAT. The data were checked for consistency and product singularity. Firms with more than four 3-digit SIC codes were excluded. (On average these were 1.96 codes per component firm.) To ensure conglomerate diversification, no segments in a given conglomerate could have overlapping codes.

Empirical Results

The empirical results indicate that CN-SG differences would not be expected in most cases since conditions (a) and (b) were generally satisfied.

To test for condition (a), 35 single-firm models were specified using the SG data. Individually identified BJ models were used to make income predictions which were compared to income predictions using RW and MA models.

Mean absolute relative errors (MAREs) were computed for a
1977-79 holdout sample. These ratios, which were computed by
dividing absolute differences between the predicted and actual
earnings by absolute values of the actual earnings, represented
averages for the single-product firms. Notationally,

$$MARE = Avg \left| \frac{P_t - A_t}{A_t} \right|$$

where P_t = predicted earnings for year t,

A_t = actual earnings for year t.

Table 1 indicates that BJ and MA models did not produce fore-
casts more accurate than RW models. Thus, condition (a) could

[Table 1 About Here]

not be rejected.[3] These MAREs are consistent with the results of
previous studies (dealing with situations other than single
product firms) and indicate that the RW model appears to best
represent the time series behavior of the SG data.

Next, following the RW branch of Figure 2, we tested for
coincidental indicators. Without significant crosscorrelations
at lags other than 0, there can be no disaggregation gains.
Conversely, with significant crosscorrelations at non-zero lags
there can be some gains.

Crosscorrelations, computed for each segment within each n-segment conglomerate, were analyzed for lags 1-4 as required for condition (b). Residuals were used to generate correlations. Since only a small number of non-zero crosscorrelations were observed (approximately 12 percent), the data indicated that condition (b) also obtained. Again, no disaggregation gains would be expected.[4]

Finally, to confirm the above results which implied that segmentation gains would not be expected, we tested the general hypothesis of no CN-SG differences by comparing CN forecasts to SG forecasts. Table 2, in confirmation of the above results,

[Table 2 About Here]

indicates that the RW forecast errors were superior. Again, we were unable to reject the null hypothesis that the RW model provides the most accurate forecasts.[5] These results held across all NOS groups.

Summary and Conclusions

For no segmentation gains to occur, two "no-gain" conditions must be satisfied: (1) the time series models for the component segments must be identified, and (2) none of the component series can lead or lag the consolidated series. Since our results supported both conditions, gains in predictive ability through disaggregation seem remote.

While annual SG profit information may be useful for a variety of other purposes (e.g., the assessment of risks), such information does not appear to be generally useful for predicting annual enterprise profits. Our results provide analytical explanation and empirical confirmation of previous CN-SG research which reached similar conclusions regarding segmented annual earnings.

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Notes

[1]Previous analyses (e.g., Fried [1978]; Barnea and Lakonishok [1980]) focused on contemporaneous crosscorrelations only. The present analysis is more general in that it examines non-contemporaneous crosscorrelations and the effect of the underlying models on CN-SG differences.

[2]This model is sometimes referred to as the "exponential smoothing" model.

[3]Statistical tests were not necessary since mean errors were in a direction opposite to that required to reject the RW null hypothesis.

[4]A detailed analysis of these cases indicated no consistent pattern of significant correlations. Since half (6 percent) of the (12 percent) significant correlations were negative, we viewed the correlations as chance significant. Negative correlations would imply negative leading indicators which appear counterintuitive. Even so, we fitted input lag-one transfer function models to cases with significant lag-one crosscorrelations. These models produced forecast errors that were virtually identical to those produced by the univariate models.

[5]Again, statistical testing would be pointless for reasons described above.

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	Condition (b)	
	Non-Zero Crosscorrelations	
Condition (a)	Non-significant	Significant
Identical Parameters	No Gains	Gains
Non-identical Parameters	Gains	Gains

Fig. 1--Analytical Results

Fig. 2--Research Design
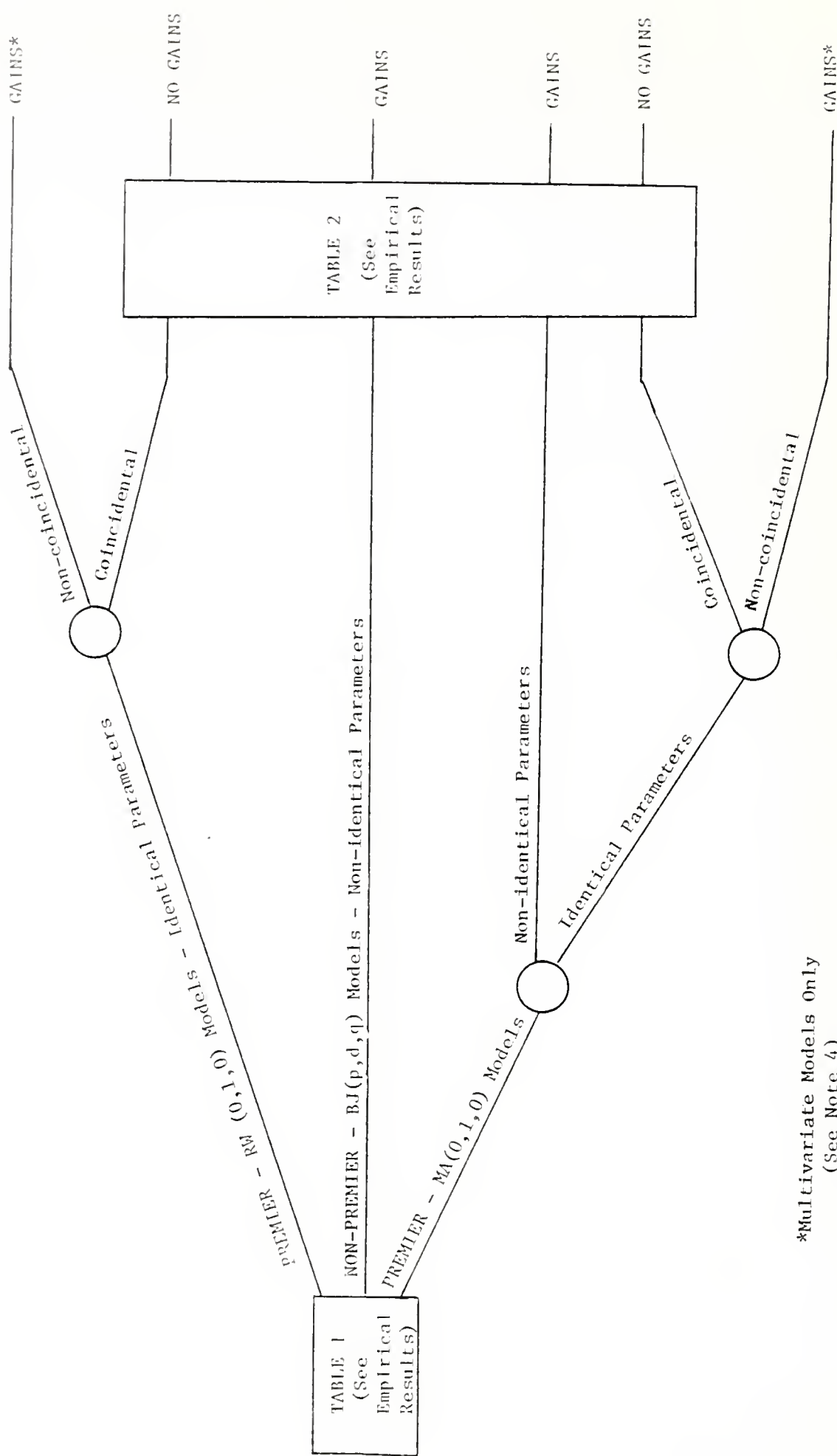
*Multivariate Models Only
(See Note 4)

TABLE 1

Predictive Ability Results

for Single-Product Firms

	MARE		
YEAR	RW	BJ	MA
1977	.2086	.2241	.2368
1978	.3038	.3295	.3183
1979	.3569	.3674	.3307
1977-79	.2896	.3070	.2953

TABLE 2

Predictive Ability Results for N-Segment

Conglomerates

Number of Segments	YEAR	CN MARE			SG MARE		
		RW	BJ	MA	RW	BJ	MA
TWO	1977	.1287	.1789	.1733	.1287	.1551	.1487
	1978	.1611	.1806	.1688	.1611	.1913	.1820
	1979	.2152	.2229	.2203	.2152	.2183	.2209
	1977-79	.1683	.1941	.1875	.1683	.1882	.1839
THREE	1977	.0738	.1382	.1059	.0738	.1353	.0869
	1978	.1640	.1668	.1756	.1640	.1807	.1659
	1979	.2118	.2067	.2129	.2118	.2233	.2109
	1977-79	.1499	.1706	.1648	.1499	.1798	.1546
FOUR	1977	.0935	.1499	.1105	.0935	.1194	.0959
	1978	.1347	.1990	.1524	.1347	.1892	.1672
	1979	.1509	.1617	.1669	.1509	.1898	.1628
	1977-79	.1264	.1702	.1433	.1264	.1661	.1417
FIVE	1977	.0585	.0574	.0814	.0585	.1075	.0727
	1978	.1145	.1371	.1230	.1145	.1523	.1461
	1979	.1784	.1821	.1795	.1784	.2155	.1734
	1977-79	.1171	.1589	.1280	.1171	.1584	.1307
Average Across Segments	1977	.0966	.1596	.1294	.0966	.1357	.1107
	1978	.1493	.1739	.1600	.1493	.1818	.1693
	1979	.1964	.2007	.2018	.1964	.2138	.1998
	1977-79	.1475	.1779	.1638	.1475	.1771	.1599